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Radiation Laboratory

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RESEARCH PROGRESS MEETING

February 26, 1948

R. K. Wakerling

Berkeley, California

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University of California
Berkeley, California

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

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Metabolism of Carrier Free Radioactive Silver in the Rat. By K.G.Scott. The manner in which rats handle small amounts of silver is different from the findings on argyrism. After the administration of about 10^{13} atoms of silver, excretion is immediately and thoroughly accomplished. This is done principally by the liver. Owing to lack of absorption from the intestinal tract, the silver is found in the fecal contents. Silver administered by stomach tube was not absorbed within the limits of the sensitivity of the method but was less than 0.1 percent in these studies. The distribution of silver in the rat after intravenous injection is the same as that observed after intramuscular injection. When the dose of silver atoms per rat was increased from 10^{13} to 10^{18}, which is a concentration commonly used in therapy, a quite different distribution of the silver in the body was obtained. This was apparently due to the inability of the liver to excrete this larger amount of silver with the efficiency it demonstrated with smaller doses. Because of this there was observed a 10 to 100 fold increase in the concentration of silver observed in such organs as liver, kidney, spleen, skin, bone, and muscle. The deposition in these tissues was proportioned to the total amount of silver administered.

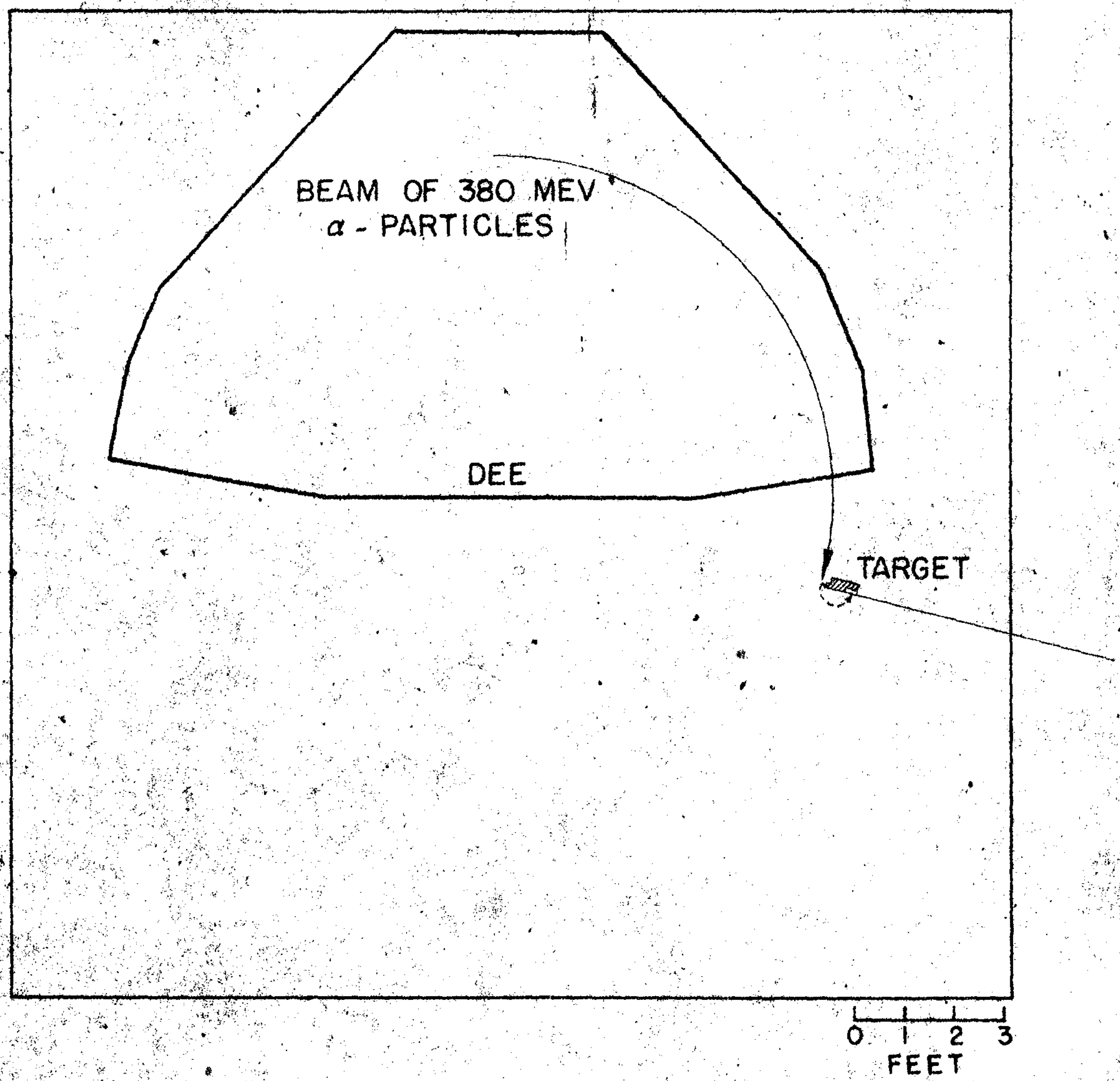
It has been shown that animals whose livers have been damaged with three hours of light chloroform anesthesia are unable to excrete a dose of silver containing as few as 10^{13} atoms efficiently. The reduction in capacity to function in this manner is enormous. It was reduced to a value of about

10^{-4} of normal. The damage is transient with recovery occuring in several days. The distribution of silver in the other tissues of the chloroform treated rats resembles that obtained when doses of silver, larger by a factor of about 10^4, are administered. The above results point the way for a development of a liver function test. If the normal route of excretion of silver is cut off by bile duct ligation, large amounts of silver pile up in the liver and other tissues of the body. Some silver is excreted in the feces after bile duct ligation, suggesting a mechanism secondary to the liver although the rate of excretion is much lower.

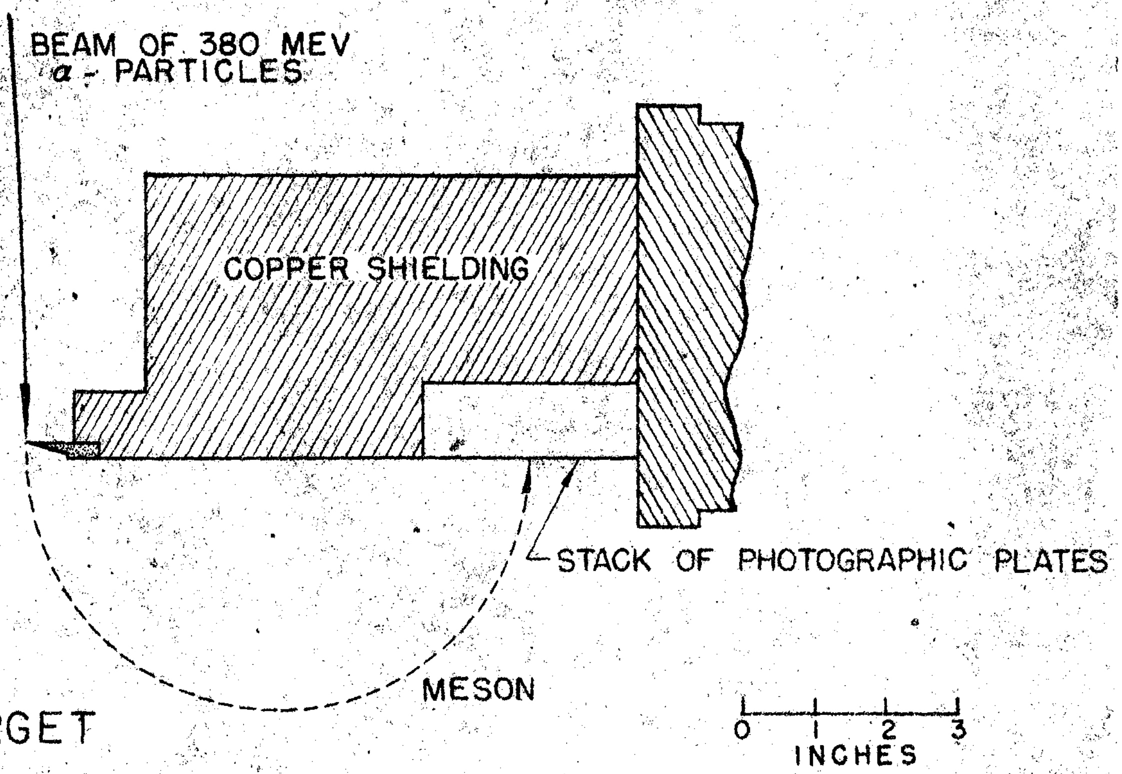
Silver atoms in concentrations of about 10^{13} atoms per cc. of blood are combined primarily on blood proteins although measurable amounts are found on the red cell membrane and in the hemoglobin. The silver was not dialyzable through cellophane. The primary carrier of silver in the blood is the blood globulin fraction although some is carried on the albumin fraction. The relative distribution of silver on the various fractions of the blood itself, since purified globulin containing silver redistributes the silver to the other protein fractions of the blood in vitro when it is added to whole blood.

Silver combined with globulin is rapidly taken from the globulin in the intact animal and excreted by the liver.

<u>The Production of Mesons by the 184-inch Berkeley Cyclotron. By E. Gardner.</u> The experimental arrangement used for the detection of mesons in the 184-inch cyclotron is shown in Figure 1. The circulating beam of 380 Mev alpha particles inside the cyclotron passes through a thin target, producing mesons and other particles. The negetive mesons are sorted out by the magnetic field and roughly focused on the edge of a stack of photographic plates as



PLAN VIEW OF CYCLOTRON



DETAIL OF TARGET

shown. The first measurements were made using a carbon target although later observations have been made with targets of beryllium, copper and uranium. Measurements are also being made to determine variation of yield with alpha particle energy.

Experiments of a preliminary nature have also been conducted in an effort to detect positive mesons. These experiments have involved placing the photographic plates above and below the circulating beam. A more satisfactory means of doing this is being devised. An experimental arrangement is also being designed whereby the target may be located permanently in place and the photographic plates run in on the probe to various distances from the target.

By C.M.G.Lattes. The identification of the particles responsible for the tracks on the photographic plates were first made on the basis of the appearance of the tracks; they show the same type of scattering and variation of grain density with residual range found in cosmic rays mesons tracks by other observers. Their appearance is sufficiently characteristic that an experienced observer can recognize them on sight. Later the identification was confirmed by a direct determination of the mass from $H\rho$ and range measurements. These showed that the particles were almost certainly the heavy mesons described by Powell and his coworkers.

The photographic plates used are Ilford Nuclear Research Plates type C.2 with an emulsion thickness of 50 microns. The percentage composition of the emulsion in terms of atom per cubic centimeter is: Hydrogen 40 percent, carbon 20 percent, oxygen 10 percent, bromine 12 percent, silver 12 percent, and nitrogen 6 percent. The exposure time is about 10 minutes and the alpha particle current about 0.1 microampere. Each of the early plates shows about 50 mesons tracks along its edge with about 10 times as many heavy particle tracks in the same area. The latter are attributed to stars and recoils produced by neutrons and are found all over the plates. Some success has been achieved in reducing the neutron background on later plates.

The opportunity for making a mass determination is furnished by the magnetic deflection of the mesons. By measuring the point and angle of incidence of each track on the edge of the plate, the radius of curvature in the field is determined. The range in the emulsion is measured with an eye piece micrometer, and to this is added the path through a one mil aluminum foil covering the plates. A total of 49 tracks have so far been measured in this way. There is no significant difference between the masses of star producing and the non-star producing particles. The mean mass of all the particles is 313 $\pm$ 16 electron masses.

This work is believed to mark the beginning of meson study under controllable laboratory conditions. The large intensities, approximately 10^8 times those available in cosmic rays, mean that the rate of progress in this field can be greatly accelerated.

Evidence of Meson Production Deduced from Nuclear Reaction Products. By G. Seaborg. Following the observation by Lattes and Gardner of cyclotron produced mesons as tracks in photographic emulsions, another attempt has been made to obtain chemical evidence for meson formation by a method which previously gave inconclusive results. This method consists of the bombardment of a target nucleus, Z with a projectile of charge z and searching for a product of atomic number Z+z+1. The particular reaction chosen for observation was the formation of $_{85}At^{211}$ following the irradiation of lead with high energy helium ions. This could presumably be formed by the reaction:

$$Pb^{208}(\alpha, n\mu^{-})\ At^{211}$$

Lead was irradiated in different experiments with helium ions of 400, 200, and 150 Mev. Parallel irradiations were carried out with bismuth as the target. In the lead targets as well as in the bismuth targets, At^{211} was identified in all cases. However, the yield in lead decreased with decreasing helium ion energy while the yield in bismuth increased sharply with decreasing energy. The yield of astatine from lead may be expressed in terms of the concentration of bismuth which would produce that yield. At 400 Mev there would have had to be 2000 ppm bismuth in the lead, at 200 Mev, 80 ppm and at 150 Mev, 5 ppm. Since spectrographic analysis indicated that the lead used contained 1-10 ppm bismuth, the astatine produced with 150 Mev helium ions could be explained by the bismuth content. At 200 Mev and particularly at 400 Mev the At^{211} could not have been produced from bismuth.

Such a mechanism as the formation of lithium nuclei from the reaction of the high energy particles on lead followed by a reation of the type, Pb(Li,xn)At, has not yet been ruled out.

The value for the cross section for the formation of At^{211} from 400 Mev helium ions on lead is 10^{-31} cm^2.

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